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NUTRIA FEEDING ACTIVITY AND ITS EFFECT ON MARSH VEGETATION IN SOUTHWESTERN LOUISIANA

SPECIAL SCIENTIFIC REPORT: WILDLIFE No. 64

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

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NUTRIA FEEDING ACTIVITY AND ITS EFFECT ON MARSH VEGETATION IN SOUTHWESTERN LOUISIANA

by

Van T. Harris, Biologist
Branch of Wildlife Research
Bureau of Sport Fisheries and Wildlife
Denver, Colorado

and

Fred Webert, Formerly Biologist
Louisiana Wild Life and Fisheries Commission
New Orleans, Louisiana

SPECIAL SCIENTIFIC REPORT -- WILDLIFE NO. 64

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ABSTRACT

A study of the effect of nutria on marsh vegetation was made in southwestern Louisiana from 1954 to 1956 by means of plant transects, exclosures, and indices to nutria abundance. Plant species studied included saltmeadow cordgrass, Olney's three-square, big cordgrass, reed, and sawgrass. Nutria had a pronounced effect, except for limited areas, only on big cordgrass. It is concluded that nutria did not have a major effect on the marsh vegetation as a whole, and did not create extensive bare areas. It is pointed out that the marsh habitat is dynamic and complex and many factors are undoubtedly involved in the changes that have occurred.

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INTRODUCTION

The establishment of the nutria or coypu (Myocastor coypus) in Louisiana has aroused interest in the United States, originally because of the fur resource it provided and later because of its tendency to damage marsh vegetation and agricultural crops. Since the escape of individuals from confinement at Avery Island, Louisiana, in 1940, nutria increased greatly in number in the Louisiana coastal marshes. Populations soon developed in the area north and west of Vermilion Bay, on Marsh Island in the Bay, and at Lacassine Refuge (Fig. 1). During the middle of the 1950's, populations increased rapidly elsewhere along the coast of Louisiana. As a result of introduction and natural spread, nutria now occupy the coastal marshes from Galveston, Texas, to northern Florida; and colonies have developed at many points inland, especially in eastern Texas.

Concomitantly with the development of large nutria populations in the Vermilion Bay region, a trend toward loss of vegetation--particularly the taller and coarser species of plants--became evident during the early part of the 1950's. Because of its abundance and food habits, the nutria became suspect for this loss of vegetation.

Some marshland owners and managers feared that these vegetative losses would cause a decrease in the wildlife resource of the marsh. However, one of the goals of waterfowl management in the Gulf States

is the opening of dense stands of large emergents (Lynch, 1948-49). Martin et al. (1957) list, among other species, reed (See table I for scientific names) and cattail as weeds of duck marshes, the latter particularly in the southern United States.

The study reported herein was undertaken to ascertain the effects of nutria activity on marsh vegetation. It was begun during late summer of 1954 and continued through the summer of 1956, and was carried out jointly by the Fur and Refuge Division, Louisiana Wild Life and Fisheries Commission and the United States Fish and Wildlife Service under the authorization of a memorandum of agreement.

Few studies of the food habits of nutria have been made in this country. Atwood (1950) listed the foods noted at feeding stations at Lacassine National Wildlife Refuge, Louisiana. Swank and Petrides (1954) studied the effect of nutria feeding on the vegetation of 11 ponds in eastern Texas.

We appreciate the suggestions and help of Ted O'Neil, Louisiana Wild Life and Fisheries Commission; John Lynch, U.S. Fish and Wildlife Service; and Leslie Glasgow, Louisiana State University. Personnel of both State and Federal refuges facilitated the studies. The National Audubon Society and the Louisiana Fur Corporation permitted studies on their land holdings; and I am indebted to the managers of the two organizations, and particularly to the latter who aided in the construction of the exclosures. Office facilities were furnished by the University of Southwestern Louisiana, Lafayette, Louisiana.

METHODS

Allegedly, the feeding activity of nutria reduces stands of vegetation to openings. The method of measuring vegetation was, therefore, designed primarily to measure openings in the vegetation. Transects were marked at 100-foot intervals with bamboo poles. Each pole established a station where the vegetation was sampled by means of a 5-foot line intercept. Along each sample line intercept, the extent in inches of clumps or patches of vegetation and of intervening open spaces was measured at ground level. Species of plants forming the clumps or patches of vegetation intercepted were listed in order of abundance. Thus, a 5 percent sample of the whole transect was obtained. Scientific names of the plant species are given in table I.

This method sampled both large openings and the small spaces between clumps or patches of vegetation and gave an index to species of plants as well. Many of the open spaces resulted from natural patterns of growth of the vegetation, but some resulted from the activity of nutria and other animals. An opening lacked the plant species that formed the usual vegetation characterizing marsh associations. Thus, an open area may have been devoid of vegetation or it may have supported those plant species, usually annuals, which invade openings.

In addition to sampling all open spaces, the total extent of large openings was measured along two transects. A large opening had a minimum diameter of 4 feet along the transect.

Vegetation measurements were made during September and October 1954; July 1955; and March and August 1956. The transects were also visited to record nutria activity in December 1954; February, April, and December 1955; and June 1956.

Additional data were secured from four nutria exclosures located as follows:

1. Near Cheniere-au-tigre several miles south of Transect B; 0.1 acre in size; constructed March 1953; vegetation first sampled August 1953.
2. At end of Transect C; 0.1 acre in size; constructed March 1953; vegetation first sampled September 1953.
3. In reed-big cordgrass type of Transect C; 0.03 acre (128 sq. ft.) in size; constructed May 1955; vegetation first sampled July 1955.
4. In reed type of Transect C; 0.03 acre in size; constructed April 1955; vegetation first sampled July 1955.

The vegetation of exclosures 1 and 2 was sampled by means of 0.1 square meter quadrats taken systematically. Vegetation from the quadrats was clipped, counted, air-dried, and weighed. The method employed for the transects was used to measure vegetation of exclosures 3 and 4.

Interpretation of the data from plant measurements was aided by statistical treatment.

Nutria activity was recorded as numbers of digging (for rhizomes) or clipping (of plants) locations, numbers of droppings, numbers of trails crossing the transects, and inches covered by nutria activity on the sample transects. For many diggings and clippings the species of plants involved were listed.

TRANSECT DESCRIPTIONS

The study areas were located in southwestern Louisiana (Fig. 1). In locating most of the transects, an attempt was made to select areas where nutria damage to vegetation was not already extensive, but where such damage might reasonably be expected to occur. The transects were not statistical samples of the various marsh plant associations in southwestern Louisiana, but they did represent areas of high nutria populations.

Transect A was located in the central portion of Marsh Island, Iberia Parish, Louisiana. It was 10,500 feet long, passing through the following vegetative types:

1. A marsh of mixed saltmeadow cordgrass and Olney's three-square, 4,900 feet.
2. A stand of big cordgrass, 600 feet, called the "north stand."
3. A firmer and slightly more elevated marsh than type 1 of saltmeadow cordgrass and saltgrass, 1,600 feet.
4. Several former stands of reed, 500 feet.
5. A series of big cordgrass stands, 3,000 feet, called "south stand."

For several years previous to the establishment of the transect, there was apparently no regular program of burning in the area of Transect A according to information available to us. Burns made for cattle management on the "sea rim" probably more or less regularly affected the last 500 feet of the transect. During the autumn of 1954 scattered burns were made along the transect. Most of the transect was burned during the autumn of 1955.

Salinities of water at the surface of the ground were generally lowest at the beginning of the transect and greatest at the end. They ranged from 7 to 29 percent of sea water.

During the summer of 1956, two stations were eliminated by the construction of a canal and levee across the transect.

Transect B, 5,100 feet in length, was located on the Paul J. Rainey Sanctuary of the National Audubon Society in Vermilion Parish. The area was selected to study the recovery of vegetation said to have been destroyed by muskrats (Ondatra zibethicus rivalicius) and later damaged by nutria. The area was formerly covered with southern bulrush, big cordgrass, reed, and cattail, the last resulting from muskrat "eat-outs." After cessation of muskrat trapping on the sanctuary in 1936, uncontrolled muskrat populations "ate out" the marsh. About 1945, nutria had increased to such an extent that further damage occurred to the vegetation (John J. Lynch, verbal communication). When nutria first appeared in the region, according to reports they showed a preference for cattail and all but eliminated it. They

then fed in turn on southern bulrush, Olney's three-square, big cordgrass, and reed.

At the beginning of the study the vegetation of the transect consisted of isolated patches of saltmeadow cordgrass, remnant stands of big cordgrass, spikerush, and various annual plants.

An early burn on the first portion of the transect prevented measurement of open space in 1954.

Transect C was located north of Belle Isle in Vermilion Parish on property of the Louisiana Fur Corporation. It started on the north slope of Belle Isle ridge and extended 4,900 feet in an easterly direction, passing through the following zones of vegetation:

1. Ridge vegetation of saltmeadow cordgrass, paspalum, and sedges, 900 feet.
2. Alternating or mixed stands of reed and big cordgrass with saltmeadow cordgrass, 1,100 feet.
3. A pure stand of reed with a ground cover of saltmeadow cordgrass, 600 feet.
4. Saltmeadow cordgrass growing in an old marsh buggy trail through a stand of reed, 1,000 feet.
5. A marsh grown to saltmeadow cordgrass with a little Olney's three-square, 1,300 feet.

Transect C was situated adjacent to an area of large nutria populations; and, according to trappers, nutria were moving onto the transect area.

The history of burning on the transect is unknown. During the late autumn of 1955, the saltmeadow cordgrass trail through the reed segment and portions of the reed segment were burned.

Salinities varied from 3.8 to 49.5 percent of sea water.

Transect D was located on Lacassine National Wildlife Refuge in Cameron Parish. The transect started at Lacassine Bayou and extended 1,600 feet into a dense stand of sawgrass. The sawgrass had been unburned for a number of years, and was a typically mature stand of clumps with leaves spreading out from the widely spaced bases to occupy the area completely. It was essentially a fresh water marsh, with salinities varying from 0.3 to 2.2 percent of sea salinity.

Transect E was also located on Lacassine Refuge about 1.5 miles north of Transect D. It was 500 feet long passing through the remnants of a southern bulrush stand into a sparse growth of sawgrass. Salinities of water at the marsh surface varied as for Transect D.

RESULTS

Transects

The results described are intended to apply only to the time and places of this study. Vegetative measurements for September-October 1954, July 1955, and August 1956, are expressed in one or more of three measurements:

1. Percentage of nonvegetated ground along the transects was calculated from measurements of open spaces and vegetative

growths on the 5-foot sample transects (table II and figures 2-9). Nonvegetated ground was used since the effect of nutria on the vegetation was expected to be manifested in open areas.

2. The percentages of large openings for Transects A and C were derived from measurements along the whole transect (table II).

3. Percentage of various combinations of the principal species of plants was calculated from the sample transect measurements (figures 2-9). For this purpose the relative abundance of each species of plant in each clump or patch of vegetation was estimated visually and considered as "dominant" if it formed 50 percent or more of the vegetation and "subordinate" if it formed less than 50 percent of the vegetation. These calculations gave a good index to changes in the density and frequency of plant species.

Changes in the vegetative pattern of the transects will not be discussed in detail. The tables and figures give the detailed information.

Overall, Transects A, B, and C showed a small decrease in the extent of nonvegetated ground (open space) from 1954 to 1955 and a greater decrease from 1955 to 1956 (table II). There were some variations in this respect from 1954 to 1955 among the vegetative types of Transects A and C (figures 2-9). Nonvegetated ground increased from 1954 to 1955 on the first two vegetative types of

Transect C. The larger decrease in nonvegetated ground occurred from 1954 to 1955, rather than from 1955 to 1956, on two vegetative types of Transects A and one of Transect C--types consisting of saltmeadow cordgrass with small amounts of Olney's three-square. Two vegetative types not shown in figures 2-9 had the following percentages of nonvegetated ground:

	1954	1955	1956
Transect A, reed type	69.0	46.7	45.7
Transect C, saltmeadow cordgrass in buggy trail	63.3	57.2	22.3

The extent of nonvegetated ground increased for Transect D from 1954 to 1956 and remained approximately the same for Transect E.

Probabilities of chance occurrence of t values of a similar magnitude for these changes in amount of nonvegetated ground are as follows:

Transect A	1954 to 1955	0.01	(105 samples)
	1955 to 1956	0.01	(105 samples)
Transect B	1955 to 1956	0.02	(51 samples)
Transect C	1954 to 1955	0.06	(46 samples)
	1955 to 1956	0.01	(46 samples)
Transect D	1954 to 1955	0.12	(16 samples)
	1955 to 1956	0.01	(16 samples)

The extent of large openings increased from 1954 to 1955 for all vegetative types of Transect A, but decreased by 1956. Large openings

decreased each year for the vegetative types of Transect C, except for the "buggy trail" type, where an increase in 1955, resulting from the activities of the investigators, caused an overall increase for the transect. These large openings were total measurements (table II), and had the variations occurring from year to year been measured as a 5-percent sample, the changes would not have been statistically significant.

Large openings on Transect A represented, for the most part, shallow, relatively permanent ponds that probably resulted from muskrat "eat-outs" 10 years earlier. Large openings on Transect C represented lack of vegetation.

Changes in the proportions of the various species of plants also occurred (figures 2-9). Decrease in nonvegetated ground was brought about by the encroachment of saltmeadow cordgrass, which increased in coverage each year in almost all of the vegetative types. In almost all cases the loss of coverage by other species was wholly or partly made up by increases of saltmeadow cordgrass. Olney's three-square decreased in extent of coverage from 1954 to 1955 wherever it occurred, except on Transect C. From 1955 to 1956 it increased beyond its 1954 coverage. The probabilities of these increases being chance occurrences are as follows for the designated transect:

A	Saltmeadow cordgrass - Olney's three-square type	1% level	(49 samples)

(Continued)

A	Saltmeadow cordgrass - saltgrass type	23% level	(16 samples)
C	Saltmeadow cordgrass - Olney's three-square type	5% level	(13 samples)

Big cordgrass as a dominant decreased in coverage and density each year, except for a small increase from 1955 to 1956 on the reed-big cordgrass type of Transect C. Evidence indicates in this exception that the increase was due more to the reed than to the big cordgrass component of the vegetation. The probabilities of these changes being chance occurrences are as follows:

A	North stand of big cordgrass	1954-55	41% level	(6 samples)
A	South stand of big cordgrass	1954-55	1% level	(30 samples)
		1955-56	8% level	(30 samples)
C	Big cordgrass-reed type	1954-55	14% level	(11 samples)
		1955-56	31% level	(11 samples)

Increases in coverage of subordinate big cordgrass did occur from 1955 to 1956 as scattered culms. Big cordgrass stands on Transect B, the north stand of Transect A, and a colony near Transect C were almost completely eradicated during the period of study.

Reed decreased in density and coverage from 1954 to 1955 and increased by 1956, reaching its 1954 coverage but not its 1954 density. The probabilities of these changes being chance occurrences are 0.06 and 0.21 respectively.

Paspalum decreased from 1954 to 1955 and increased in 1956 to cover a larger area than in 1954. The probability of the latter change is approximately 0.20 ($n = 9$).

The increase in nonvegetated ground on Transect D reflected a change in the density of sawgrass, since that was the most abundant vegetation present. During March 1956 the sawgrass at one place on the transect appeared to be less dense than elsewhere, and by June this tendency was marked along a quarter of the transect. Apparently the sawgrass was dying, for dead, broken-off clumps were present. During early summer the following year the marsh was swept clean by a hurricane, and the ultimate fate of the die-off could not be determined.

Exclosures

Exclosures were established to ascertain the effect of nutria on vegetation by protecting it from the nutria. Data for exclosure 1 are given in table III. During the 5 months between construction and the first vegetation measurements, vegetation improved visibly inside the exclosure, and the difference between mean weights per sample inside and outside the exclosure at the end of this period in 1953 was significant at the 6 percent level with the higher mean inside. In 1956 there was a significant difference (3 percent level) between means, with the higher mean inside. Number of stems of all species, however, was not significantly different inside and outside during the 4 years. In 1956 the vegetation inside the exclosure

appeared to be taller and more robust than outside, probably accounting for the fewer stems but greater weight inside. Revegetation of small openings created by the activities of the nutria produced smaller and more numerous stems outside the exclosure. Olney's three-square and big cordgrass, both food plants of the nutria, showed significantly higher means inside than outside the exclosure by analysis of variance. The average number of culms of Olney's three-square decreased with time both inside and outside, but at a greater rate outside. The average number of culms of big cordgrass fluctuated inside the exclosure with time, but decreased steadily outside the exclosure.

Exclosure 2, located in the saltmeadow cordgrass - Olney's three-square type of Transect C, was invaded by muskrats late in 1953. The activities of the muskrats affected the vegetation in the exclosure, hence only data for 1953 are given in table IV. By July 1953, 5 months after construction of the exclosure, the vegetation appeared denser and taller inside than outside the exclosure. Comparison shows that the means per quadrat were significantly different at the 5 percent level with the higher mean inside for weight of vegetation, total number of stems, and number of culms of saltmeadow cordgrass.

Exclosure 3 was erected in the only dense colony of big cordgrass remaining along Transect C in May 1955. The purpose of choosing this location was to ascertain if, protected from nutria, the big cordgrass would deteriorate as it appeared to be doing

elsewhere along the reed-big cordgrass type of the transect. Table V shows that big cordgrass coverage increased to a greater extent from 1955 to 1956 within the exclosure than on the transect. Inches of nonvegetated ground did not differ appreciably inside and outside; the decrease from 1955 to 1956 was caused largely by increased coverage of saltmeadow cordgrass along the transect and by increased coverage of big cordgrass in the exclosure. Also, the portion of the big cordgrass colony lying outside the exclosure had become noticeably thinner by 1956.

Exclosure 4, in the reed type of Transect C, showed no effect on the vegetation due to protection (table VI). Inches of dominant reed decreased slightly inside the exclosure from 1955 to 1956 while it increased outside. Inches of nonvegetated ground decreased to a greater extent inside than outside the exclosure.

Nutria Abundance

Counts of nutria droppings, diggings, and trails on the transects, when broken down by vegetative types and seasons, did not provide a reliable, quantitative index to nutria abundance which could be correlated with vegetative change, because the data were too few. Table VII records the counts of food diggings along each transect. A general trend toward a decreased number of diggings per 100 feet of transect is noted for 1956, especially on Transects A and C where nutria were most numerous. The number of inches of the sample transects showing nutria activity, recorded in table VIII, also shows a slight downward trend.

Trapping data could not be associated with the areas on which the transects were located because boundaries of trapping units changed somewhat from year to year. However, the transects were located in that part of southwestern Louisiana where numbers of nutria first settled and where large populations developed. By 1953 in the western portion of Marsh Island, numerous trails could be seen from the air (verbal communication, John J. Lynch). During three trapping seasons, the following numbers of nutria were taken from Marsh Island:

1953-54	10,042
1954-55	13,578
1955-56	14,833

General observation of nutria activity in the region of Transect A indicated that the 1955-56 trapping removed a larger proportion of the nutria population than during the previous trapping season, and that nutria were less abundant during 1956 than previously.

No trapping was permitted on the Rainey Wildlife Sanctuary where Transect B was located. Nutria apparently had been numerous on the sanctuary, but along Transect B they appeared to be less abundant than on Transects A and C.

Transect C was located on that portion of the lands of Louisiana Fur Corporation which produced the highest nutria catch.

Trapping records for the corporation as a whole follow:

Winter Season	Furs Sold
1953-54	49,428
1954-55	62,807
1955-56	52,096
1956-57	45,014

The trapping program of Louisiana Furs was well managed and trapping pressure was remarkably constant. It is believed that the figures represent a real population decline during 1955, inasmuch as field sign in general clearly supported this.

There were relatively few nutria on Transects D and E. Old signs on Transect E attested to previously greater numbers of nutria.

Vegetation Involved in the Feeding Activity of Nutria

In our area nutria feed largely upon rhizomes and the basal, fleshy portions of stems of many species of plants. These are obtained by digging when the ground is bare and soft, or covered with a few inches of water. Diggings were usually not more than 6 inches deep and 6 or 8 inches across. Feeding of one or more nutria was often concentrated, so that the soil of an area varying in size to an acre or more might be thoroughly disturbed. When several inches or more of water covered the ground, plants were clipped near the base or the upper portions removed.

The species of rhizomes dug from the soil provide only circumstantial evidence of the feeding habits of the nutria; no

stomach or dropping analyses were made. In many areas the digging of one species of rhizome would necessarily result in uncovering and removing another species. Saltmeadow cordgrass, present over much of the marsh, was often found together with other species in a digging. By comparing the proportion of diggings or clippings involving a plant species with the estimated proportion of that species in the vegetation, some insight may be gained into the food habits of the nutria.

Tables IX, X, and XI present these comparisons for Transects A, B, and C. The presence of each species in the vegetation was estimated from the sample transects. In pure stand, a species was given the total inches along which it occurred. If dominant over another species, it was arbitrarily accorded two-thirds of the recorded inches; the remaining one-third was assigned to the subordinate species, or divided equally among them if more than one subordinate species was present. Total inches of a species was taken as a percentage of the total inches of vegetation. Likewise, the presence of plant fragments of each species in a nutria digging or clipping was recorded, and the total for the plant species was taken as a percentage of the total diggings and clippings, thus obtaining a percentage occurrence. Occasional plant species that did not occur on the transect appear in the tables because the samples of diggings were often not taken directly along the line of the transect, but always close to it.

Saltmeadow cordgrass was distributed over much of Transects A and C and was found in most of the diggings. Usually it was proportionally less abundant in the diggings than in the vegetation as a whole. This plant was widespread and digging for other food species often must have necessarily involved cordgrass rhizomes. Saltmeadow cordgrass culms and rhizomes are slender, and certainly do not provide a choice food item. Nevertheless, this species appears to be a common item of the nutria's diet where it occurs.

Olney's three-square was represented in a much higher proportion of diggings than its presence in the vegetation would indicate. The large culms and rhizomes appear to provide a favorable source of food. Rare three-square plants along Transect B and experimental plantings of three-square in the region were quickly utilized by nutria.

Big cordgrass also occurred in a larger proportion of diggings and clippings than in vegetation. More than half of the "cane" recorded in table XI consisted of big cordgrass. The basal portion of the culm of this species is thick and the rhizome stout. The data, together with our observations, suggest that among the species studied, big cordgrass is a preferred food of nutria.

Reed is another species with large rhizomes and basal culms. It occurred in a large proportion of diggings but formed a smaller portion of the vegetation. Rhizomes and the basal culms of reed are relished by nutria, but apparently to a lesser extent than those of big cordgrass. Reed formed the smaller part of the "cane"

reported in table XI. The preference of nutria for big cordgrass and reed was especially evident where these plants occurred as scattered individuals or in small colonies. Old rhizomes of these two species were sometimes dug out by nutria on Transect B.

Sawgrass necessarily formed the bulk of the nutria's food on Transect D. The low nutria population in this vegetation type, in a region of various vegetative types where nutria early developed and maintained a substantial population, would suggest that a mature sawgrass stand does not provide preferred food.

Other species of plants occurred as minor components of Transects A, B, and C. Among these, cattail and wild millet seemed to be selected as food by the nutria where they occurred. Cattail occurred rarely on the various saltmeadow cordgrass types of Transects A and C, and on Transect D, but was not recorded on the transects. Wild millet formed small percentages of the vegetation on Transects B and C. Sedge species without tuberous rootstalks were utilized during winter where other food was scarce, as on Transect B.

DISCUSSION

At the peak of the nutria population in our area during the summers of 1954 and 1955, openings (both large and small) occupied a large percentage of the area crossed by the transects. With the decrease of the nutria population, probably beginning during the summer of 1955, there was an immediate recovery of the vegetation.

This general correlation needs further discussion because of our failure to measure nutria abundance adequately for quantitative correlation.

Its feeding habits contribute to the concept that nutria have a pronounced effect on vegetation. The present studies and general observation attest to the catholic taste of the nutria in vegetation. The size of the animal and the fact that only a small portion of the plant is eaten result in much waste of vegetation. This selective feeding often results in destruction because the rhizome, a favorite portion of many food plants, must be dug from the ground. The digging results in little piles of debris which cover germinating plants. Feeding is sometimes concentrated over small areas. Sign of nutria was always more apparent during winter; partly, perhaps, because the retarded growth of plants in this season could not keep pace with the food requirements of the animal. With the higher populations of nutria (estimated from trapping records) approaching 3 animals per acre in our area, these feeding habits would be expected to affect the vegetation.

Winter feeding during 1954-55 on the saltmeadow cordgrass, Olney's three-square segment of Transect A, resulted in numerous areas up to 50 feet in diameter where the vegetation was reduced by an estimated 50 to 80 percent. On the other hand, the vegetative reproduction of the marsh plants is vigorous, and the above "eat-out" areas were not discernible by the following summer.

A piece of reed culm bitten off by nutria provides another example of this vigorous reproduction. The discarded section had sprouted culms and roots at the node.

Of the marsh plants studied, saltmeadow cordgrass was least affected by nutria and weather. It recovered from nutria feeding within a season or two and was able to invade openings and occupy areas from which other species were disappearing. Saltmeadow cordgrass has been considered an edaphic subclimax in marshes less susceptible to standing water (Lynch et al, 1947), and our data support this, in that the plant occurred often under stands of big cordgrass and reed and was able to promptly revegetate open areas.

Saltmeadow cordgrass is an important source of food to geese, marsh birds, and songbirds, and is used by muskrats to some extent (Martin et al, 1951). It is also important in providing a turf in Olney's three-square marshes (John J. Lynch, unpublished data). The loss of big cordgrass stands on Transects A and C, and revegetation by saltmeadow cordgrass might permit management by burning toward Olney's three-square.

Optimum conditions for Olney's three-square growth appear dependent upon water conditions combined with burning (Lynch, 1941). In the past it has increased during periods of wet years and decreased during drought periods (O'Neil, 1949, and trappers' information). Its rhizomes provide good food for nutria. Nutria activity on the saltmeadow cordgrass - Olney's three-square type was nearly as great as that on the big cordgrass type, and within the type

was greater where three-square was most prevalent. Nutria feeding reduced the density of Olney's three-square and caused some openings; and stands were improved with protection from nutria (exclosures 1 and 2) and with a reduced nutria population in 1956 combined with more nearly optimum water conditions. With optimum growing conditions the loss of Olney's three-square in large stands to nutria might have been less than that experienced in 1955.

Olney's three-square is the most important food of geese and muskrats in the Gulf Coast marshes (Lynch, 1941). In feeding on three-square, nutria compete to some extent with muskrats and wintering geese.

Stands of big cordgrass were so high and dense on Transects A and C as to impair vision when the transects were laid out, but lost their identity as stands by 1955. The stands on Transects A and C and a colony near the saltmeadow cordgrass type of Transect C were almost completely destroyed by nutria, as were already debilitated stands on Transect B. Nutria activity was more intense in big cordgrass stands than in other vegetative types and big cordgrass rhizomes provided a preferred food. Big cordgrass protected from nutria (exclosure 3) continued to thrive.

All big cordgrass stands on the transects showed less than optimum growth when the transects were established. We cannot say with certainty whether this condition was due to nutria activity previous to our study, or to changes in the habitat. The growth

of big cordgrass within the exclosures suggests that the activity of nutria caused more rapid deterioration than did the effects of physical factors of the habitat.

Big cordgrass is chiefly of value as cover to other marsh animals, but is a secondary food for muskrats and geese (Lynch et al, 1957).

Reed was utilized by nutria to a considerable extent for food and shelter. Although the reed stand on Transect C decreased in density in 1955, it recovered in 1956. There was no indication that nutria harmed the stand and reed protected from nutria by exclosure 4 showed no increased coverage. Colonies of reed on Transect A were already dead when the transect was established during the fall of 1954. The remaining stubble seemed firmly attached to the roots and showed stem breakage, indicating that most of the plants were not killed by the digging of nutria. One of us (F.W.) observed large stands of reed and cattail to the west of the transect in 1952, but by 1954, stands of reed were reported by a trapper as dead and dying in that area. The trapper did not believe that nutria were responsible for the loss.

It is possible that repeated clipping by nutria of new shoots might prevent reproduction of a stand and eventually kill it, but this is difficult to believe because of the vigorous vegetative reproduction of large stands growing under optimum conditions. To provide evidence, all reed shoots in two 6-foot square quadrats were clipped for 1.5 years. At the end of a spring and summer's

growth following the clipping, one quadrat showed a diminished number of culms and the other no difference in comparison with the controls.

Reed is often a pioneer plant (Warren S. Bourn, verbal communication), but once established, it may persist indefinitely and is resistant to control, especially when growing in water (Martin et al., 1957). Reed crossed by Transect C was burned in the fall of 1955. The reed type was unharmed by the fire, but the reed growing on either side of the buggy trail, at a slightly higher elevation and with a denser understory of saltmeadow cordgrass, was nearly eliminated. Apparently the ability of the nutria or other factors to damage reed depends upon deviations from rather precise environmental conditions.

On the other hand, reports have indicated rather clearly that small stands of reed fringing bayous and ponds in the marsh have been destroyed by nutria. Nutria have destroyed small stands of reed in Germany and Poland (cited by Ehrlich, 1957), Israel (Glazner, 1958), England (cited by Laurie, 1946), and Russia (Vereshchagin, 1941).

Aside from the protection it affords, reed has little value to waterfowl and muskrats and is considered a pest plant in duck marshes (Martin et al., 1957). However, it is commonly used to build duck blinds in the Louisiana marshes.

Mature sawgrass did not appear to provide a good habitat for nutria. The number of sawgrass culms cut by nutria on Transect D

could not have been responsible for the decrease in density of the stand. However, burning may cause vulnerability to nutria by increasing the number and availability of new shoots.

Sawgrass was dying throughout southwestern Louisiana during the early 1950's, but some marsh managers did not attribute this loss to nutria. During the late 1920's sawgrass was present as isolated colonies in areas east and south of Pecan Island in Vermilion Parish and also near Sweet Lake in Cameron Parish, according to longtime residents. These colonies gradually increased to form dense stands that characterized the areas by 1950. This indicates that factors other than nutria have caused changes in coverage of sawgrass.

Sawgrass has value as cover for marsh animals. It is generally considered to be of little value for waterfowl and muskrats (Martin et al., 1957), although its seeds were found in great amounts in waterfowl gizzards recently studied in southwestern Louisiana (Chamberlain, 1959).

That Southern bulrush may have been previously thinned by nutria on Transect E was suggested by the old sign present. Several hundred yards north of the transect, bulrush in the same zone was much denser. A bulrush marsh north of the impoundment on Lacassine Refuge was greatly thinned by nutria soon after their appearance there (John J. Lynch, verbal communication), and feeding of both cattle and nutria caused the disappearance of a bulrush stand at Delta Refuge. Other bulrush stands at

Lacassine Refuge and south of Pecan Island have been affected by nutria only around edges next to canals or bayous. A dense bulrush stand is evidently not a favored nutria habitat in southwestern Louisiana.

Southern bulrush is not of great importance to muskrats in the brackish marsh (Lynch et al., 1957). Its seeds form an important part of the diet of ducks in the region (Chamberlain, 1959).

Cattail, existing as a minor vegetative type in southwestern Louisiana, is said to be a favorite food of nutria there (Dozier, 1951) and in Washington (Guenther, 1950). Cattail existing as isolated plants on Transects A, C, and D were frequently utilized as food by nutria. Small stands of cattail were "clear-cut" in Texas (Swank and Petrides, 1954) and in Russia (Vereshchagin, 1941) and almost completely eliminated in Israel (Glazner, 1958), England (Laurie, 1946) and in Germany and Poland (cited by Ehrlich, 1957).

The discussion of the effect of nutria on the plant species studied indicates that, with the exception of big cordgrass and cattail, nutria have not been a primary cause of the loss of emergent, marsh vegetation in southwestern Louisiana. On the contrary, general observation has led us to believe that dense marsh vegetation does not provide optimum conditions for nutria. Nutria seem to prefer areas where vegetation is open or where it is interspersed with openings and made available by canals, pirogue ditches, and natural waterways. Much of their movement is along trails made by them or other animals, and trails made by man or marsh

buggies are promptly utilized. Any agency such as drought, grazing, muskrat and goose eat-outs (Lynch et al., 1947), hurricanes and marsh buggy activities (Harris and Chabreck, 1958), that thins or destroys vegetation, appears to improve the habitat for nutria. Man's activities, as well as natural events, may have been a factor in determining the numbers of nutria in the marshes of southwestern Louisiana.

Man's activities and natural events provide other factors (which we did not study) that have caused changes in the marsh and probably have affected the marsh vegetation. A brief review of these factors illustrates the dynamic and complex nature of the marsh habitat which makes it unlikely that any one species of animal can be the sole cause of a noticeable ecological change.

A drought of at least four years ended with 1955. If a retardation of one year is permitted, the vegetational changes also correlate roughly with rainfall. During the drought period the accumulated deficiency was approximately 70 inches, 10 inches more than a normal year's precipitation, and during 1954 it was 50 percent of normal. Rainfall during 1955 was near normal, and a deficiency of 7 inches was recorded for the first half of 1956. Precipitation varies locally on the coastal marshes, but these records from nearby weather stations illustrate the trend.

Increased salinities accompany decreased precipitation. Our salinity records are few; on Transect C three measurements

averaged 42.6 percent of sea salinity in October 1954; four averaged 21.7 percent in June 1956; and five averaged 10.1 percent in August 1956. The drought, with accompanying salinity variations, may have affected some plant species adversely through 1955, and the increased rainfall of 1955 may have been a factor in the increased vegetation coverage of 1956. Little is known of the precise effects of rainfall and salinity, or of other environmental factors, singly and in combination, on the various species of marsh plants.

Changes other than weather may have affected the marsh vegetation. The increased number of canals required by the oil industry and navigation has changed the drainage patterns in the marsh. This and flood control activities have reduced water levels on the marsh by drainage and channeling runoff through the marsh into the gulf. The marsh has become more accessible to gulf water through these channels. In southwestern Louisiana increased usage of fresh water for rice farming has reduced amounts reaching the marsh. These gradual changes have shortened the period of time that rain or runoff water lies on the marsh and have increased the number of times that saline gulf water covers the marsh. It is fair to assume that such changes modify vegetative density and composition. Improperly applied management techniques have also changed plant composition and density.

Once established, a perennial marsh plant, with its vigorous, vegetative reproduction, may persist for some years while conditions

are becoming less optimum for it (John J. Lynch, verbal communication). The probability exists that the environmental changes outlined above may have had much to do with the losses of some of the larger emergent plants which have been noticed in southwestern Louisiana during the 1950's. Nutria, in this complex and dynamic habitat, do not appear on the whole to be a decisive factor among those already affecting the marsh vegetation.

SUMMARY AND CONCLUSIONS

A study of the effect of nutria on marsh vegetation was made in southwestern Louisiana from 1954 to 1956 by means of plant transects, exclosures and indices to nutria abundance.

Nutria populations were high on most of the transects through the summer of 1955 and declined thereafter. The proportion of openings in the vegetation of three of the transects decreased slightly from 1954 to 1955 and to a greater extent from 1955 to 1956. The proportion of openings remained the same for one transect and increased on a fifth transect because of the gradual dying-out of the vegetation. The feeding habits of nutria are shown to be conducive to wasteful use of the vegetation.

Nutria feeding had little permanent effect on saltmeadow cordgrass and no effect on mature sawgrass of the stands studied. Nutria thinned stands of Olney's three-square, but this effect seems to be less critical than that of habitat factors. The reed stands studied were utilized but unaffected by nutria;

small zonal and fringing stands seem to be more vulnerable. Southern bulrush is thinned or destroyed in some localities, but only edges of stands are affected in other localities. Big cordgrass stands were eliminated by nutria on the transects. Rare cattail plants were heavily utilized and nutria are reported by others to damage and destroy cattail stands.

Extensive areas of openings did not develop on the transects with the higher populations of nutria, for saltmeadow cordgrass tended to occupy these openings and to replace other species that diminished in coverage. It is shown that many factors are changing in the dynamic marsh habitat, and these factors undoubtedly have effects, not assessed in this investigation, on the composition and density of marsh vegetation.

It is concluded that the nutria did not have a primary or major effect by creating openings on the marsh vegetation as a whole in the areas represented by the transects. A general assessment of the value of the vegetation to desirable forms of wildlife suggests that the effect of the nutria, through vegetation, on this wildlife is less than a major one.

REFERENCES CITED

Atwood, Earl L. 1950. Life history studies of nutria, or coypu, in coastal Louisiana. J. Wildl. Mgmt., 14(3): 249-265.

Chamberlain, J. L. 1959. Gulf Coast marsh vegetation as food of wintering waterfowl. J. Wildl. Mgmt., 23(1): 97-102.

Dozier, Herbert L. 1951. The present status and future of nutria in the southeastern states. Southeastern Assoc. Game and Fish Comm., 5th Ann. Meeting. Mimeographed. 10 pp.

Ehrlich, S. 1957. On the importance of raising nutria in fish ponds. Bamidgeh, 9(4): 65-69.

Glazner, M. 1958. First report on the growth of nutria in fish ponds and their influence on destruction of coarse vegetation. Bamidgeh, 10(2): 32-35.

Guenther, Stanley E. 1950. Nutria. Game Bull. (Washington State), 2(1).

Harris, Van T. and Robert H. Chabreck. 1958. Some effects of Hurricane Audrey on the marsh at Marsh Island, Louisiana. Proc. Louisiana Acad. Sci., 21: 47-50.

Laurie, F. M. O. 1946. The coypu (Myocastor coypus) in Great Britain. J. Animal Ecol., 15(1): 22-34.

Lynch, John J. 1941. The place of burning in management of the gulf coast wildlife refuges. J. Wildl. Mgmt. 5(4): 454-457.

Lynch, John J. 1948-49. The water weed problem from the standpoint of wildlife and fisheries. Proc. Soil Sci. Soc. Florida, 9: 58-65.

Lynch, John J., Ted O'Neil, and Daniel W. Lay. 1947. Management significance of damage by geese and muskrats to Gulf Coast marshes. J. Wildl. Mgmt. 11(1): 50-76.

Martin, Alexander C., Ray C. Erickson, and John H. Steenis. 1957. Improving duck marshes by weed control. U.S.D.I., Fish and Wildl. Serv. Circ. No. 19. Rev. 60 pp.

Martin, Alexander C., Herbert S. Zim, and Arnold L. Nelson. 1951. American wildlife and plants. McGraw-Hill Book Co., Inc., New York. 500 + ix pp.

O'Neil, Ted. 1949. The muskrat in the Louisiana coastal marshes. Louisiana Dept. of Wild Life and Fisheries, New Orleans, 152 + xii pp.

Swank, Wendell G. and George A. Petrides. 1954. Establishment and food habits of the nutria in Texas. Ecology 35(2): 172-176.

Vereshchagin, N. K. 1941. Establishment of the nutria in West Georgia. Trans. Inst. Zool. Acad. Sci. R.S.S.G., 4: 3-42. (Translated by H. D. Jackson, Oxford, England).

TABLE I. Common and scientific names of plants mentioned in the text and tables

Common Name	Scientific Name
Arrowhead	*Sagittaria lancifolia*
Big cordgrass	*Spartina cynosuroides*
Cattail	*Typha* sp.
Deer pea	*Vigna repens*
Olney's three-square	*Scirpus olneyi*
Paspalam	*Paspalum* spp.
Reed	*Phragmites communis*
Rush	*Juncus* spp.
Saltgrass	*Distichlis spicata*
Saltmarsh bulrush	*Scirpus robustus*
Saltmeadow cordgrass	*Spartina patens*
Sawgrass	*Cladium jamaicense*
Sedge	*Cyperus* spp.
Sesbania	*Sesbania macrocarpa*
Southern bulrush	*Scirpus californicus*
Sprangletop	*Leptochloa fascicularis*
Spikerush	*Eleocharis* spp.
Switchgrass	*Panicum virgatum*
Wild millet	*Echinochloa* spp.

TABLE II. Amount of nonvegetated ground and large openings as percentages of the total transect lengths

Transect		October 1954	July 1955	March 1956	August 1956
A:	Nonvegetated ground	55.1	46.5	44.5	28.0
	Large openings	8.0	11.3	9.3	9.0
B:	Nonvegetated ground	----	95.1	94.6	91.0
C:	Nonvegetated ground	60.2	55.3	55.2	29.8
	Large openings	1.3	2.1	3.2	0.5
D:	Nonvegetated ground	73.8	80.5	80.1	89.4
E:	Nonvegetated ground	97.0	96.0	98.0	98.0

TABLE III. Mean amounts of vegetation per quadrat inside and outside nutria exclosure 1 near Cheniere-au-Tigre

	No. of Plots	1953	1954	1955	1956
Weight in grams[1/]					
Inside	20	134.6	93.2	105.9	159.9
Outside	39	90.6	85.9	112.7	112.2
No. of stems, all species[2/]					
Inside	20	81.4	88.5	94.3	88.4
Outside	39	66.3	87.5	114.6	121.6
No. of culms, Olney's three-square[3/]					
Inside	14	4.7	3.8	1.0	1.3
Outside	20	4.8	0.5	0.1	0.2
No. of culms, big cordgrass[3/]					
Inside	6	10.2	6.3	9.7	5.0
Outside	14	7.9	4.5	2.6	1.0

1/ Difference between means for location: prob. 0.02; for years: prob. 0.01

2/ Differences among means for years: prob. 0.01

3/ Differences between means for locations and years: prob. 0.01

TABLE IV. Mean amounts of vegetation per quadrat inside and outside nutria exclosure 2 in saltmeadow cordgrass - Olney's three-square type (20 samples each location) of transect C for 1953

	Inside	Outside
Weight of vegetation in grams	101.04*	83.69*
No. of stems, all vegetation	93.6*	58.1*
No. of culms, saltmeadow cordgrass	72.4*	39.7*
No. of culms, Olney's three-square	18.9	17.2

* Difference between inside and outside means: prob. 0.05

TABLE V. Comparison of mean measurement of vegetation inside and outside nutria exclosure 3 in reed-big cordgrass type (4 samples each location) of transect C

Item	Inside (Exclosure) 1955	Inside (Exclosure) 1956	Outside (Transect) 1955	Outside (Transect) 1956
Inches of non-vegetated ground[1/]	44.3	8.3	44.3	12.3
Inches of dominant big cordgrass[2/]	15.3	50.8	3.8	8.5

1/ Difference between inside means for 1955-56: prob. 0.01

Difference between outside (transect) means for 1955-56: prob. 0.07

2/ Difference between inside means for 1955-56: prob. 0.01

Difference between inside and outside (transect) means for 1955: prob. 0.05

Difference between inside and outside (transect) means for 1956: prob. 0.01

TABLE VI. Comparison of mean measurements of vegetation inside and outside nutria exclosure in reed type of transect C

Item	Inside		Outside	
	1955	1956	1955	1956
Number of samples	4	4	5	9
Inches of non-vegetated ground[1/]	39.3	14.3	32.2	20.6
Inches of dominant reed[2/]	6.5	4.3	3.6	13.6

1/ Difference between inside means for 1955-56: prob. 0.01

2/ Difference between outside means for 1955-56: prob. 0.06

TABLE VII. Average number of nutria diggings per hundred feet on the transects

Transect	Dec. 1954	Feb. 1955	Apr. 1955	Dec. 1955	Mar. 1956	June 1956	Aug. 1956
A	----	----	6.2	3.5	1.9	1.5	2.3
B	0.9	0.8	0.9	1.2	0.6	0.5	2.6
C	8.3*	10.2*	1.9	5.1	0.6	0.7	1.2
D	1.3	----	2.1	4.6	4.7	3.3	2.5
E	5.0*	----	3.4	5.4	3.2	----	3.2

* Partially estimated

TABLE VIII. Number of inches of nutria activity per hundred feet of transect from a 5% sample

Transect	Oct. 1954	July 1955	Mar. 1956	Aug. 1956
A	114	62	67	34
B	11	26	14	21
C	115	57	51	40
Total	240	145	132	95

TABLE IX. Percent occurrence of plants involved in nutria feeding activities in relation to percent vegetative composition on transect A (2,680 diggings)

Species	April 1955		Dec. 1955 and Mar. 1956		June and August, 1956	
	Diggings	Vegetation	Diggings	Vegetation	Diggings	Vegetation
Saltmeadow cordgrass	59.5	91.5	91.8	90.7	78.8	86.3
Olney's three-square	31.0	4.9	64.0	8.4	57.6	9.5
Big cordgrass	46.2	3.1	22.6	0.5	18.7	2.2
Saltmarsh bulrush	1.2	0.3	0.3	0.4	4.3	1.0
Sedge	0.0	0.0	0.0	0.0	1.5	0.3
Deer pea	0.0	0.2	0.1	0.0	0.0	0.7
Reed	0.0	0.0	1.8	0.0	0.2	0.0
Cattail	1.2	0.0	0.0	0.0	0.0	0.0
Sesbania	0.0	0.0	0.0	0.0	0.5	0.0
Wild millet	0.0	0.0	0.0	0.0	0.2	0.0

TABLE X. Percent occurrence of plants involved in nutria feeding activities in relation to percent vegetative composition on transect B (359 diggings)

Species	Dec. 1955 and March 1956 Diggings	Dec. 1955 and March 1956 Vegetation	June and August 1956 Diggings	June and August 1956 Vegetation
Saltmeadow cordgrass	11.6	21.1	4.9	10.7
Olney's three-square	2.5	0.7	0.0	0.0
Big cordgrass	11.1	5.2	8.7	1.9
Reed	2.5	0.0	1.2	0.0
Southern bulrush	0.5	0.0	0.0	0.0
Sedge	49.5	0.8	0.0	6.2
Spike rush	22.2	60.5	33.5	15.1
Wild millet	0.0	0.0	46.6	16.8
Paspalum	0.0	0.0	0.0	2.8
Sprangletop	0.0	6.6	5.0	25.4
Other species	0.0	5.1	0.0	21.1

TABLE XI. Percent occurrence of plants involved in nutria feeding activities in relation to percent vegetative composition on transect C (558 diggings)

Species	Feb. and April 1955 Diggings	Feb. and April 1955 Vegetation	Dec. 1955 and Mar. 1956 Diggings	Dec. 1955 and Mar. 1956 Vegetation	June and Aug. 1956 Diggings	June and Aug. 1956 Vegetation
Saltmeadow cordgrass	47.8	90.3	68.9	80.7	12.9	73.3
Paspalum	5.4	1.9	6.9	3.6	8.5	4.3
Olney's three-square	27.1	0.7	46.9	3.3	9.4	1.7
"Cane"	27.1	2.7	33.7	4.6	26.7	4.5
Reed	5.4	2.5	13.4	2.8	33.6	2.9
Wild millet	0.0	0.8	0.0	0.0	21.6	4.3
Rush	6.5	0.3	1.4	1.0	0.0	0.0
Spikerush	0.0	0.0	0.6	3.1	0.0	trace
Switchgrass	1.1	0.0	0.0	0.9	0.0	0.4
Sedge	0.0	0.0	0.0	0.0	3.4	4.3
Saltmarsh bulrush	0.0	0.0	0.0	0.0	0.0	0.1
Arrowhead	4.3	0.0	0.0	0.0	0.9	0.0
Cattail	4.3	0.0	0.0	0.0	1.7	0.0
Other species	0.0	0.8	0.0	0.0	0.0	3.7

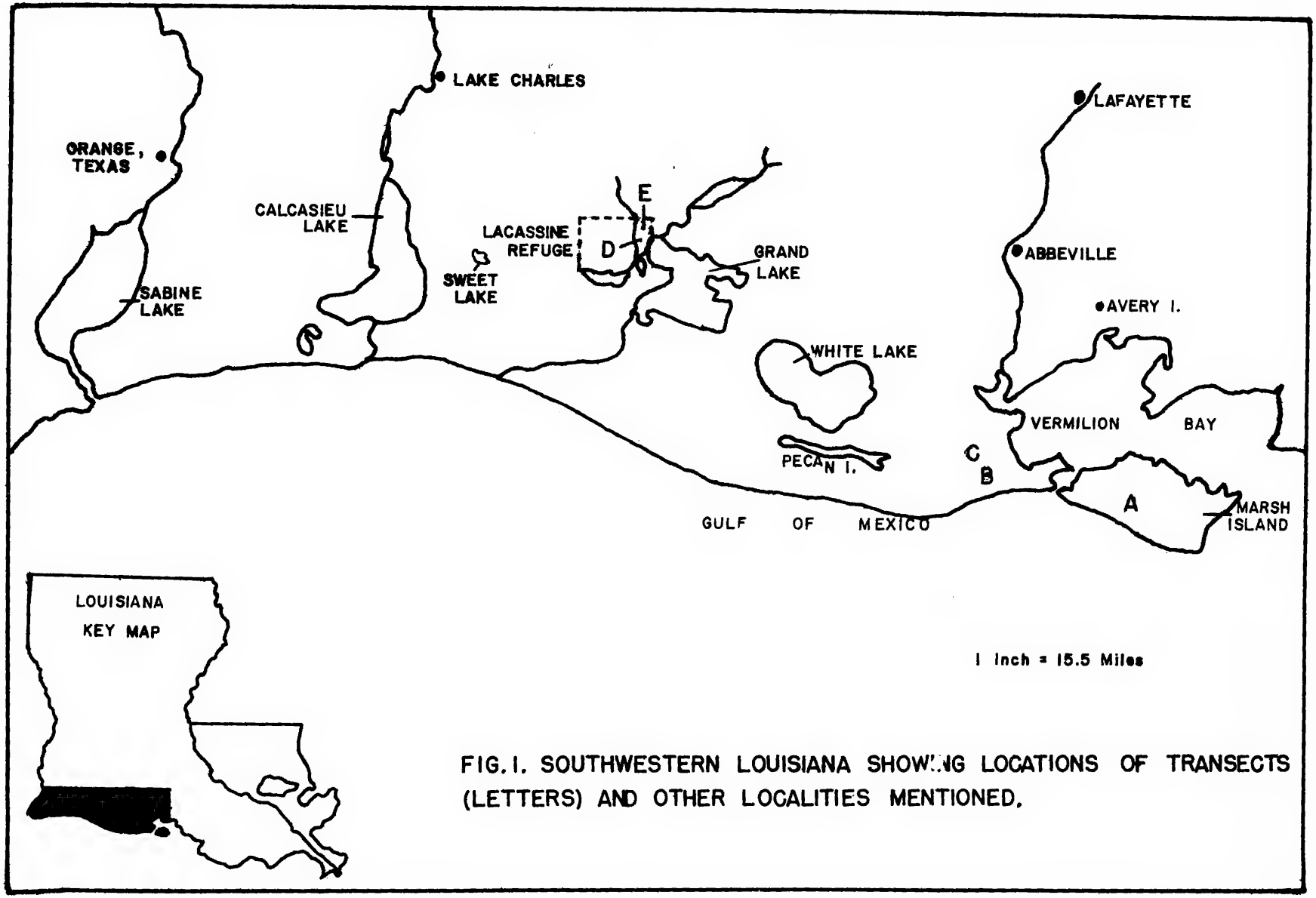

FIG. 1. SOUTHWESTERN LOUISIANA SHOWING LOCATIONS OF TRANSECTS (LETTERS) AND OTHER LOCALITIES MENTIONED.

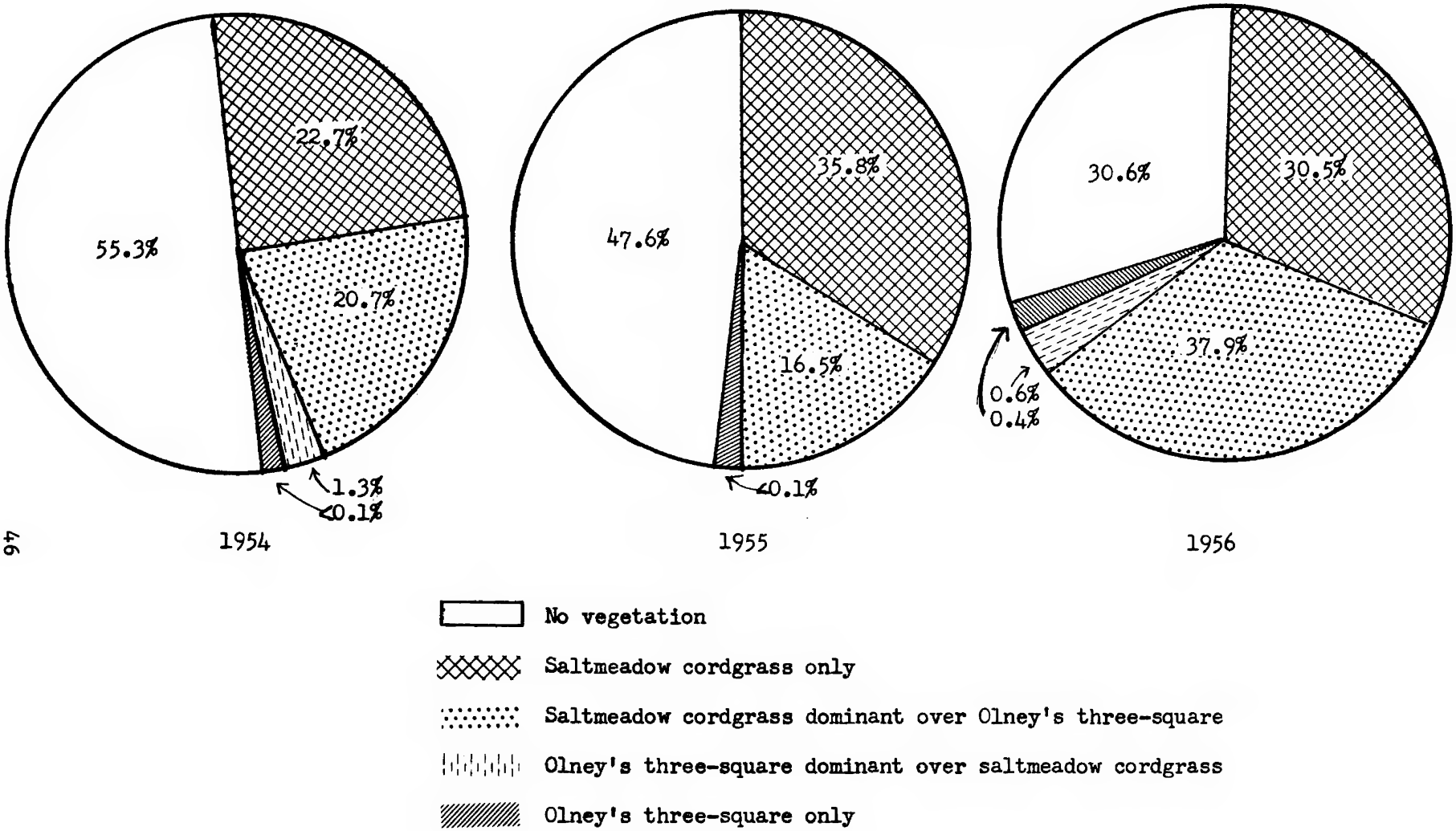

Fig. 2. Vegetational changes on the saltmeadow cordgrass - Olney's three-square vegetative type of transect A during three years.

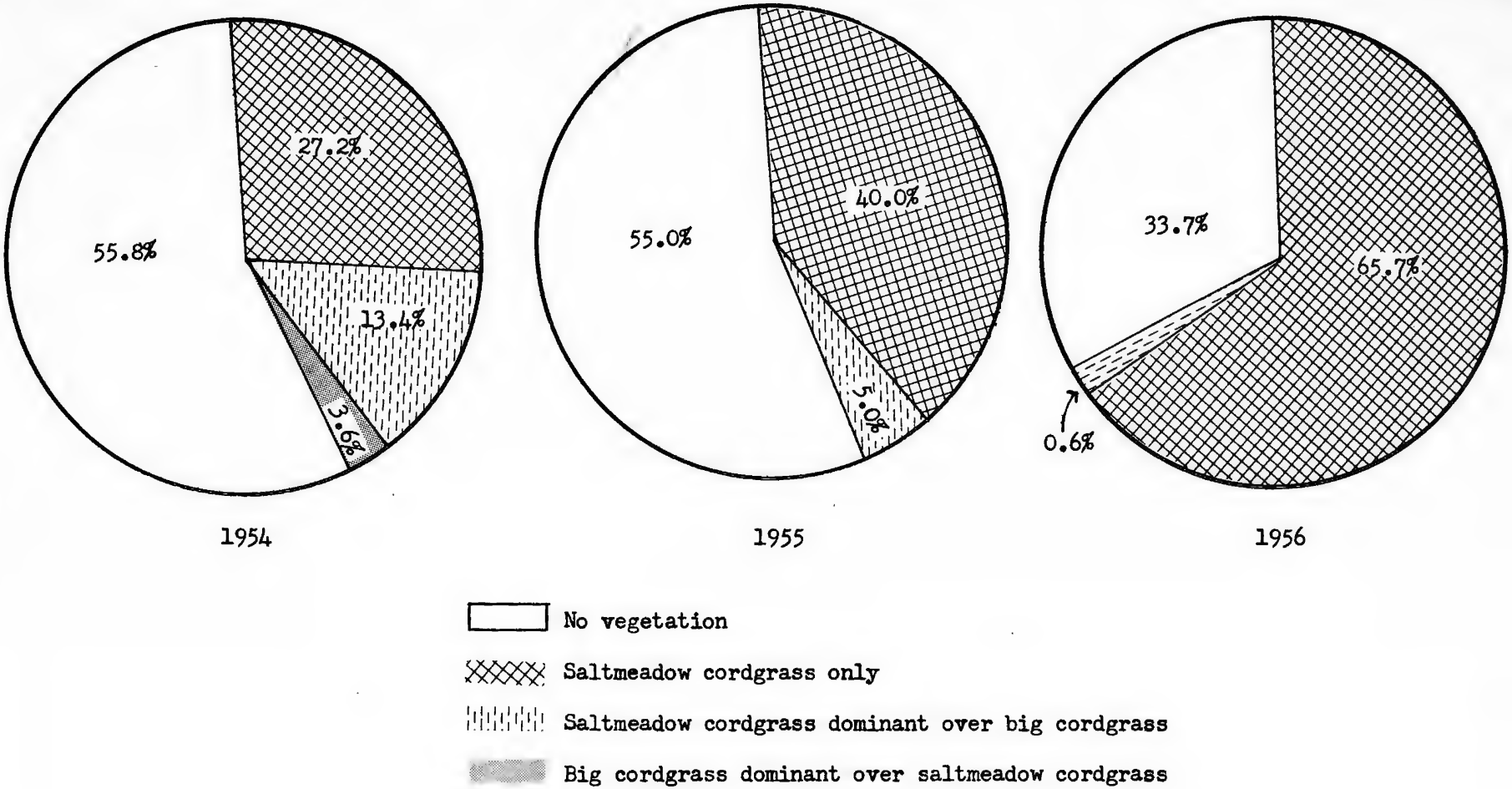

Fig. 3. Vegetational changes on the north big cordgrass vegetative type of transect A during three years.

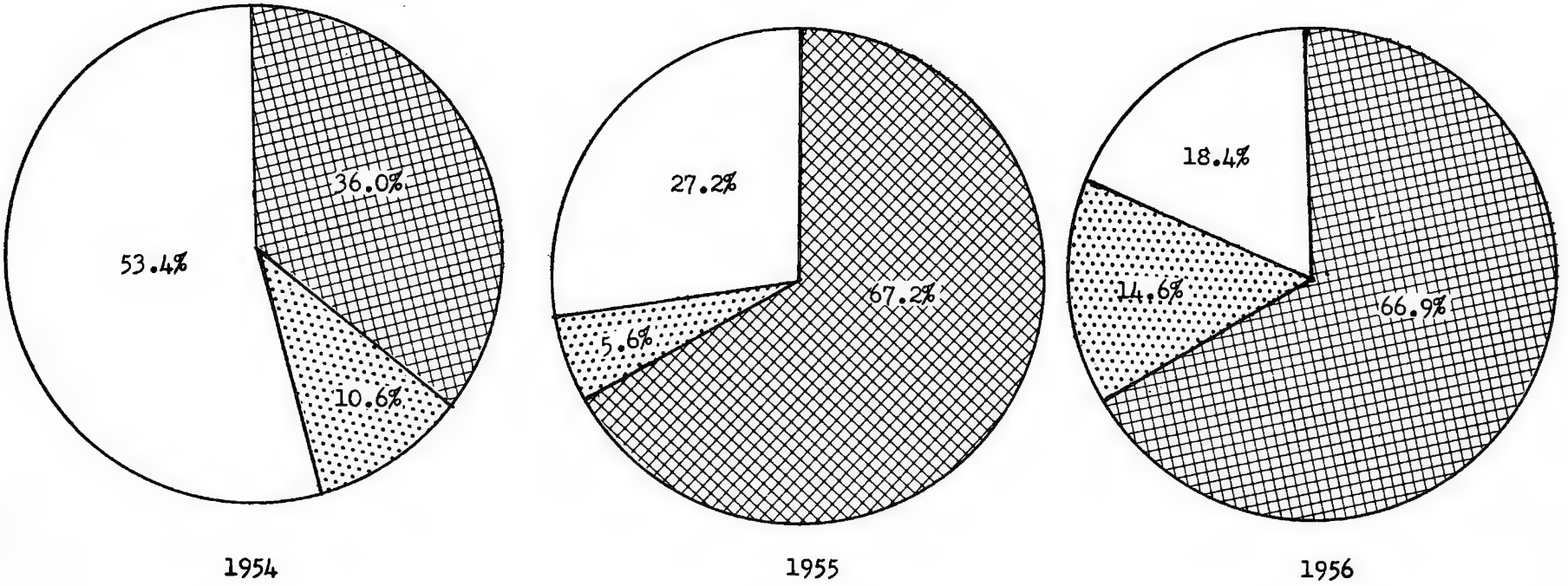

Fig. 4. Vegetational changes on the saltmeadow cordgrass-saltgrass vegetative type of transect A during three years.

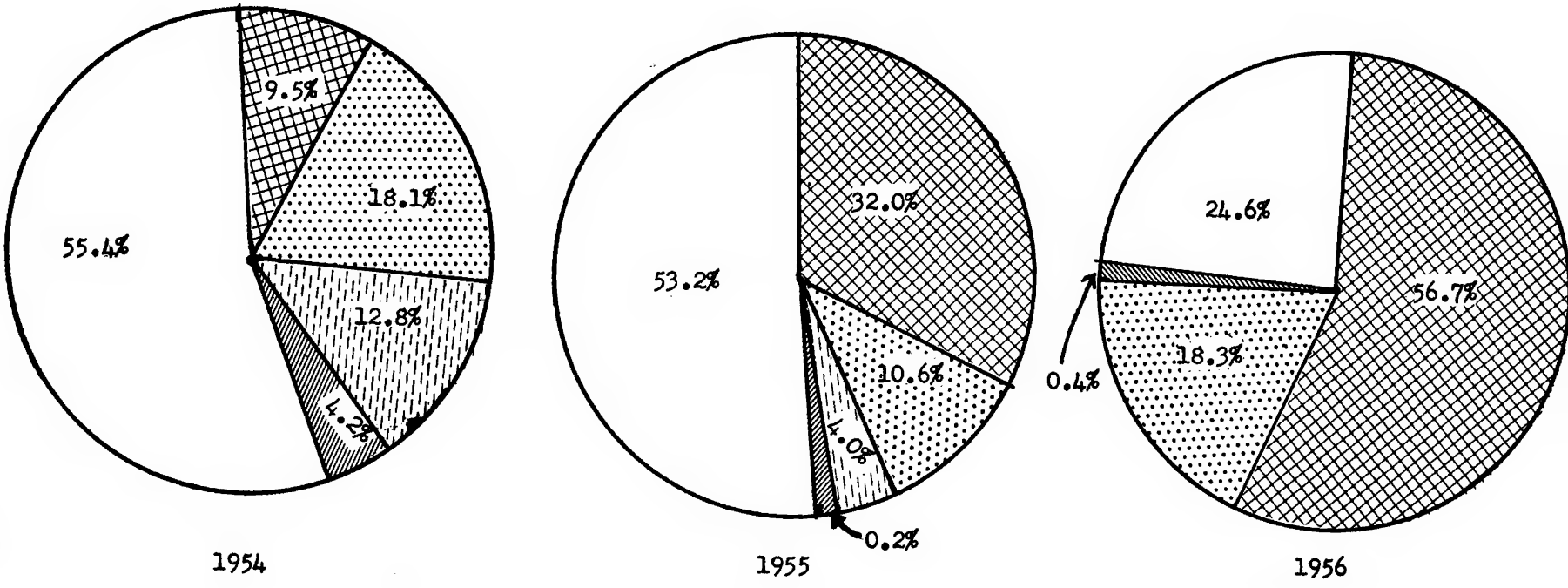

Fig. 5. Vegetational changes on the south big cordgrass vegetative type of transect A during three years.

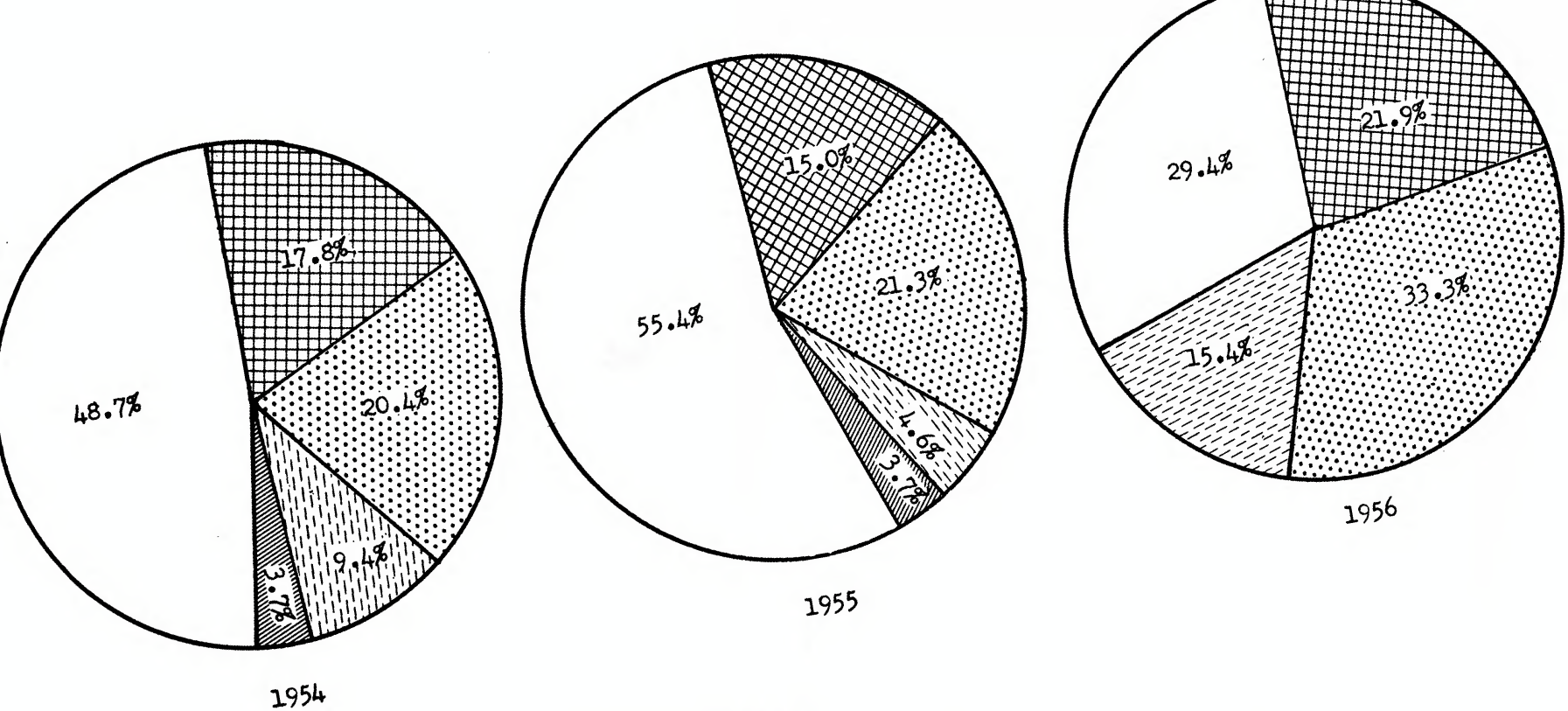

Fig. 6. Vegetational changes on the saltmeadow cordgrass - paspalum vegetative type of transect C during three years.

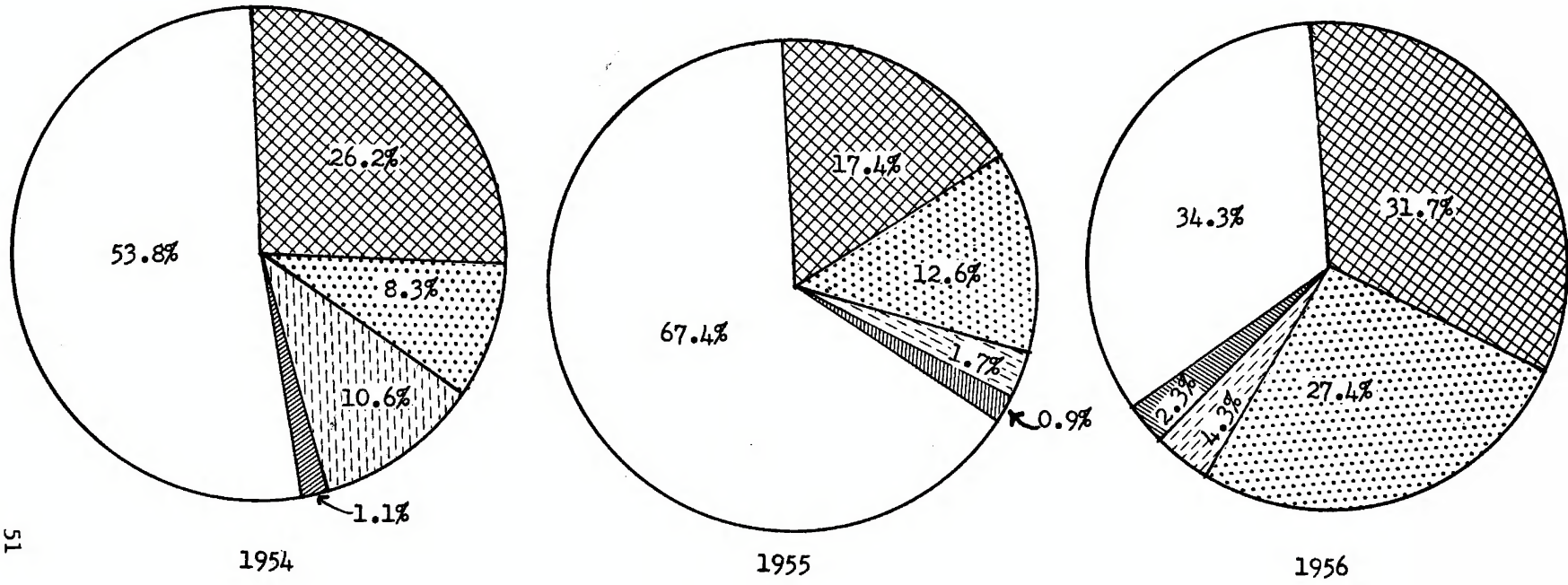

Fig. 7. Vegetational changes on the reed - big cordgrass vegetative type of transect C during three years.

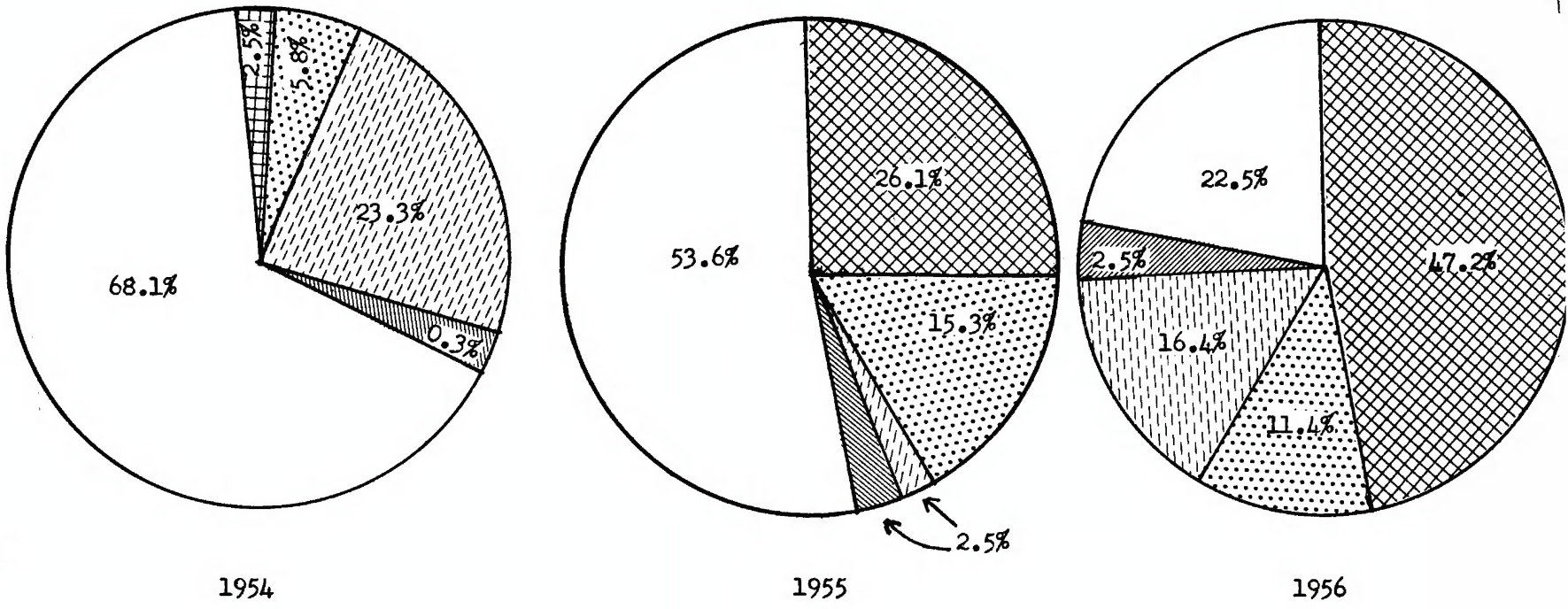

Fig. 8. Vegetational changes on the reed vegetative type of transect C during three years.

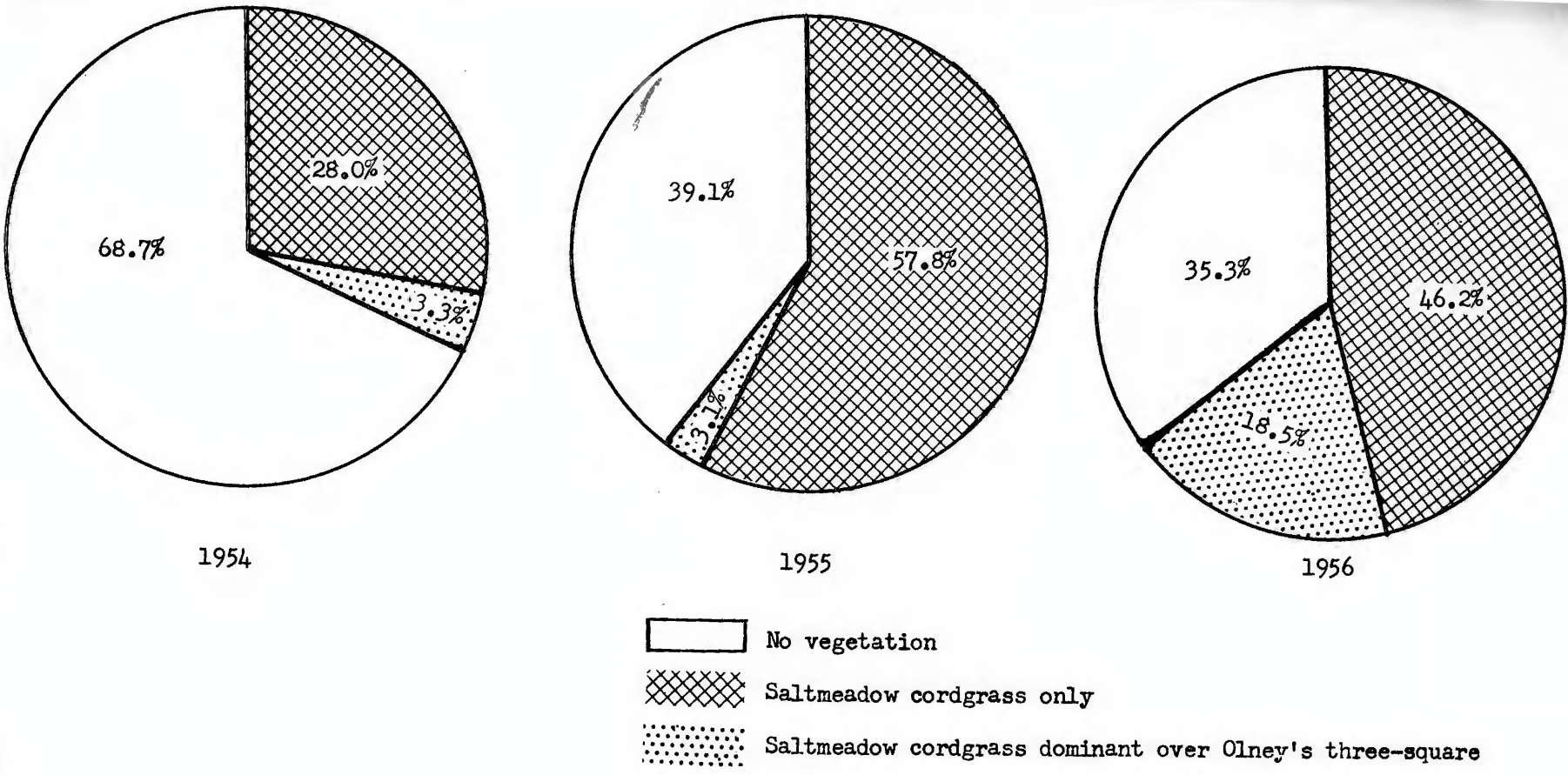

Fig. 9. Vegetational changes on the saltmeadow cordgrass - Olney's three-square segment of transect C during three years.

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